In re Patent Application of:
OLSSON ET AL.
Serial No. 09/147,230
Filed: FEBRUARY 9, 1999

In the Claims:

This listing of claims replaces all prior versions and listing of claims in the application. **Note that double brackets (e.g. [[delete]] have been used to indicate deletions in the claims.**

Claims 1-29 (Canceled).

30. (canceled).

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~~31~~. (Previously presented) A receiver, for use in an OFDM transmission system in which data is transmitted in frames, each frame having a cyclic prefix which is a repetition of part of the frame, the receiver comprising:

a sampling oscillator;

an adaptive equalizer having an equalizer inverse channel model;

separation means for separating the equalizer inverse channel model into a first and a second part, the first part being independent of sample timing and the second part being dependent on sample timing; and

control means for controlling the sampling oscillator based upon the second part.

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~~32~~. (Previously presented) A receiver according to Claim ~~31~~ 1 wherein said control means comprises estimation means for estimating timing deviations of said sampling oscillator; and wherein said estimation means operates entirely on frequency domain input data.

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3 ~~33~~. (Previously presented) A receiver according to Claim ~~32~~ 2 wherein said estimation means estimate an approximation of a linear portion of an argument function produced by timing deviations of said sampling oscillator.

4 ~~34~~. (Previously presented) A receiver according to Claim ~~32~~ 2 wherein said estimation means finds the linear portion of the argument function by taking an average slope of the argument function.

C1 Cont.

5 ~~35~~. (Previously presented) A receiver according to Claim ~~34~~ 4 wherein the approximation of the linear portion of the argument function is used as a feedback control signal for said sampling oscillator.

6 ~~36~~. (Previously presented) A receiver according to Claim ~~35~~ 5 further comprising a control loop for said sampling oscillator; and wherein the approximation of the linear portion of the argument function has a slope which converges to zero as the control loop settles.

7 ~~37~~. (Previously presented) A receiver according to Claim ~~36~~ 6 wherein parts of the equalizer inverse channel model, other than the linear portion of the argument function, are controlled by said adaptive equalizer which continuously adapts to variations in sampling timing.

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7 8 ~~38~~. (Previously presented) A receiver according to Claim ~~37~~ 7 wherein said adaptive equalizer and said control means each use defined and different portions of the equalizer inverse channel model to achieve an output frequency domain signal with zero phase deviation relative to a transmitted signal.

Cnt Cont TO 210

6 9 ~~39~~. (currently amended) A receiver according to Claim ~~36~~ 6 wherein the slope of the argument function α_k is estimated from an equation

$$[[\ \alpha_k = \frac{1}{N}\sum_n L\frac{(X_{n,k})/(Y_{n,k})}{n}\ ]]$$

$$\underline{\alpha_k = \frac{1}{N}\sum_n L\frac{X_{n,k}}{n}}$$

where N is the number of active carriers and $\underline{X_{n,k}}$ [[(Xn,k)/(Yn,k)]] is the unwrapped argument function for an nth active carrier in a kth frame.

6 10 ~~40~~. (currently amended) A receiver according to Claim ~~36~~ 6 wherein the slope of the argument function α_k is estimated from an equation

$$[[\ \alpha_k = \frac{2}{n_2 - n_0}\left[\sum_{n=n_1+1}^{n_2} L(X_{n,k})/(Y_{n,k}) - \sum_{n=n_0}^{n_1} L(X_{n,k})/(Y_{n,k})\right]\ ]]$$

TO 211

$$\underline{\alpha_k = \frac{2}{n_2 - n_0}\left[\sum_{n=n_1+1}^{n_2} LX_{n,k} - \sum_{n=n_0}^{n_1} LX_{n,k}\right]}$$

where N is the number of active carriers, $\underline{X_{n,k}}$ [[(Xn,k)/(Yn,k)]] is the unwrapped argument function for an nth active carrier

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in a kth frame, indices n_0 and n_2 are lower and upper limits respectively of a band and index n_1 which divides the band into two equal parts.

41. (canceled).

42. (canceled).

43. (canceled).

Cont

~~44~~ 11. (Previously presented) An OFDM transmission system in which data is transmitted in frames, each frame having a cyclic prefix which is a repetition of part of the frame, the OFDM transmission system comprising:

a receiver comprising

a sampling oscillator,

an adaptive equalizer having an equalizer inverse channel model,

a separation circuit for separating the equalizer inverse channel model into a first and a second part, the first part being independent of sample timing and the second part being dependent on sample timing, and

a controller for controlling the sampling oscillator in dependence on the second part.

45. (canceled).

~~46~~ 12. (Previously presented) In an OFDM system in which data is transmitted in frames, each frame having a

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cyclic prefix which is a repetition of part of the frame, and in which the receiver comprises an adaptive equalizer having an equalizer inverse channel model, a method of synchronizing a receiver sampling oscillator with a transmitter sampling oscillator, the method comprising:

separating the equalizer inverse channel model into a first and a second part, the first part being independent of sample timing and the second part being dependent on sample timing; and

controlling a sampling oscillator based upon the second part.

C1 Cont

12 13 ~~47~~. (Previously presented) A method according to Claim ~~46~~ further comprising estimating timing deviations of the receiver sampling oscillator entirely from frequency domain input data.

13 14 ~~48~~. (Previously presented) A method according to Claim ~~47~~ wherein estimating comprises estimating an approximation of a linear portion of an argument function produced by timing deviations of the receiver sampling oscillator.

14 15 ~~49~~. (Previously presented) A method according to Claim ~~48~~ wherein estimating an approximation of a linear portion of an argument function comprises taking an average slope of the argument function.

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14 16 ~~50~~. (Previously presented) A method according to Claim ~~48~~ further comprising using the approximation of a linear portion of an argument function as a feedback control signal for the receiver sampling oscillator.

16 17 ~~51~~. (Previously presented) A method according to Claim ~~50~~ wherein the approximation of a linear portion of an argument function has a slope which converges to zero as a control loop for the receiver sampling oscillator settles.

C7 Cont

17 18 ~~52~~. (Previously presented) A method according to Claim ~~51~~ further comprising controlling parts of the equalizer inverse channel model, other than the linear portion of the argument function, with the adaptive equalizer which continuously adapts to variations in sampling timing.

14 19 ~~53~~. (Previously presented) A method according to Claim ~~52~~ wherein the adaptive equalizer and the control loop each use defined and different portions of the equalizer inverse channel model to achieve an output frequency domain signal with zero phase deviation relative to a transmitted signal.

~~20~~ 20 ~~54~~. (currently amended) A method according to Claim 17 ~~51~~ wherein estimating the slope of the argument α_k uses an

$$[[\ \alpha_k = \frac{1}{N}\sum_n L\frac{(X_{n,k})/(Y_{n,k})}{n}\ ]]$$

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$$\underline{\alpha_k = \frac{1}{N}\sum_n L\frac{X_{n,k}}{n}}$$

where N is the number of active carriers and $\underline{X_{n,k}}$ ~~[[(Xn,k)/(Yn,k)]]~~ is the unwrapped argument function for an nth active carrier in a kth frame.

17 ~~55~~ 24. (currently amended) A method according to Claim ~~51~~ wherein estimating the slope of the argument function α_k uses an equation

$$[[\ \alpha_k = \frac{2}{n_2 - n_0}\left[\sum_{n=n_1+1}^{n_2} L(X_{n,k})/(Y_{n,k}) - \sum_{n=n_0}^{n_1} L(X_{n,k})/(Y_{n,k})\right]\ ]]$$

$$\underline{\alpha_k = \frac{2}{n_2 - n_0}\left[\sum_{n=n_1+1}^{n_2} LX_{n,k} - \sum_{n=n_0}^{n_1} LX_{n,k}\right]}$$

where N is the number of active carriers, $\underline{X_{n,k}}$ ~~[[(Xn,k)/(Yn,k)]]~~ is the unwrapped argument function for an nth active carrier in a kth frame, indices n_0 and n_2 are lower and upper limits respectively of a band and index n_1 which divides the band into two equal parts.

21 ~~56~~ 22. (Previously presented) A method according to Claim ~~55~~ further comprising adjusting frame timing, upon starting, until received frames are sampled within a signal interval.

22 ~~57~~ 23. (Previously presented) A method according to Claim ~~56~~ wherein adjusting the frame timing comprises adjusting the frame timing in accordance with a feed back

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C1 Cont.

signal so that the sampling oscillator maintains frame synchronization.

58. (canceled).

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